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Maximization of the velocity circulation in a flow around a smooth contour with sources and sinks

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Abstract

The problem of lift maximization for a smooth closed contour of given length with point singularities (sources and sinks) placed in an inviscid incompressible flow is analyzed under the condition that the stagnation (zero-velocity) points lie on the contour. A mathematical formulation of the corresponding optimization problem is given. Its analytical solution is reduced to two simpler problems, which are investigated numerically in the general case. Some specific cases are considered. It is shown that the circulation reaches its maximum on a circumference when all sources merge into a single source and all sinks merge into a single sink. It is concluded that the lift increases in the presence of singularities in extremal flow regimes and at certain flow rates to values that cannot be attained for impermeable contours.